

Implementing LID for New Development

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The policy makers have jumped on the Low Impact Development (LID) bandwagon and have given the marching orders to staff: LID For Everyone! Come back with an implementation plan.

This is the story of LID in *Somewhere*, Florida. While the name is fictitious, the rules and procedures in *Somewhere* are drawn from real conditions and municipal regulations typical of many cities. Ordinances are different in every city, but the examples given in this paper will illustrate typical administrative procedural challenges that cities can expect to encounter while going down the road of requiring LID practices in new development.

LID stormwater practices revolve around the concept of providing a variety of on-site, distributed, small-scale, landscaped features and engineered devices that capture rainwater, slow down runoff, enhance filtration, and filter out pollutants before the runoff assimilates into large volumes in traditional stormwater systems.

LID BMPs have two types of applications.

1. In retrofit situations for ultra urban developed areas with no treatment systems, and
2. In new development where the intent is to replace or reduce sizes of regional treatment systems with numerous smaller BMPs. Keep in mind that using LID practices in Florida will not eliminate the need for detention ponds. There will always be the requirement for matching pre verses post discharge rates, resulting in flood storage ponds that LID practices can only partially offset.

This paper explores the implications of changing new development regulations in *Somewhere* to require or allow developers to use LID practices for a hypothetical subdivision. The perspective is from that of *Somewhere's* Public Works Department (PWD) and how their subdivision process would change to embrace LID practices.

Existing Subdivision Process

The subdivision process is necessarily complex, refined by years of experience with many different development scenarios. A bit of background is in order for those not familiar with subdivision rules in *Somewhere*, or the new development game in general. There are four traditional roles in *Somewhere's* development regulations.

1. The **developer**, who must obtain permits from the City and construct required infrastructure, including stormwater conveyance and treatment systems, according to *Somewhere's* design and construction standards.
2. The **engineer** hired by the developer to secure permits for constructing the subdivision by preparing plans meeting *Somewhere's* design standards.

3. The **City**, whose engineers, permittees, and inspectors assure that new construction adheres to the City's subdivision regulations.
4. The **homebuilder**, who, in this scenario, is a speculative builder that will sell a finished home to a homebuyer.

The developer starts the process by buying land and hiring an engineer to start laying out roads and lots. The primary goal of the developer is to maximize the number of lots at the least cost for infrastructure, which in this discussion is stormdrain pipes, ditches, and treatment ponds. The biggest challenge to the engineer is the stormwater design, which in *Somewhere* requires matching pre versus post discharge rates and providing 1.0 inch of treatment volume, typically in wet or dry ponds. These requirements determine pipe and pond sizes. The greater the pond size, the lower the lot count. The larger the pipe sizes, the greater the cost of piping and fill material to raise the roads over the pipes.

The engineer spends considerable time and money optimizing pond sizes, road elevations, and fill required for each lot. Each lot must have a grading plan that directs runoff toward a conveyance system (pipe, ditch, or street) that is maintained by the City in a public right-of-way or easement. The stormwater ponds are located on land with drainage easements dedicated to the City so PWD staff can access the ponds for inspections and emergency repairs during flood conditions. This is an important point to remember. Easements allow City staff to undertake pond repairs for emergency flood relief. Routine maintenance of ponds for aesthetics, flood control, and treatment purposes is performed by a Home Owners Association (HOA), not the City.

As part of the permitting process, the developer must post a bond covering the cost of constructing the roads and infrastructure, including the stormwater ponds. The City requires the bond in case the developer does not construct the improvements per City specifications. In the circumstance of unsatisfactory or non-completion of the infrastructure, the City will cash the bond to obtain funding to complete the works themselves. Upon completion of the infrastructure, the City will perform a final inspection that triggers acceptance of the infrastructure to City ownership, final recording of the plat, and release of the bond. At that point the developer can sell lots to the homebuilder (a bank will not lend money to a home builder or buyer without a final recorded plat). The developer is still responsible for maintaining the infrastructure for a one-year warranty period after acceptance of facilities by the City.

One of the important items inspected by the City is the stormwater system. Constructing ponds to the correct dimensions assures that homeowners receive a 25-year level of flood protection for the ponds and 10-year level of service for drain pipes as required by code. Allowing a developer to build a stormwater system that provides less than 25 and 10-year flood protection is a sure invitation to lawsuits by homeowners against the City when the next hurricane rolls around. This important point will be discussed further below.

Another concept to keep in mind is that the City is required to meet FDEP TMDL allocations of certain pollutant discharge levels for new development, meaning in Florida that BMPs are designed and permitted to match pre versus post pollutant loads, assuring

that new development has no net increase on nutrient loadings to stormwater runoff. The City bears the responsibility of compliance with TMDL requirements. The City cannot pass off responsibility of pollutant treatment to developers, homebuilders, or homeowners in private or public subdivisions.

The homebuilder is responsible for construction of the sidewalks and driveways; typically the last items to be built after the home construction crews leave the site. A Certificate of Occupancy (CO) issued to the homebuyer is not issued until the sidewalks and driveways are constructed. If sidewalks and driveways were built by the developer early in the home building process, trucks and equipment of the home builder would damage these items, leading to much conflict over repairing this infrastructure required by, owned by, and maintained by the City. This conflict resolution would lead to delays in approvals by the City, and in turn to the inability of the homebuilder to close on the sale of a house, causing excited calls to City management by homebuilders and homebuyers accusing inspectors of holding up bank closings. The reason for belaboring this point will become evident below.

Another important point to understand is that the City has two types of inspectors. The first is the Public Works inspector who assures the roads, infrastructure, ponds, and lot grading are built according to the approved plans. In this City of 100,000 people there is one Public Works inspector to handle all new development infrastructure inspections. He also inspects the driveways and sidewalks constructed by the homebuilder.

The second type of inspector is from the Building Department. Building inspectors in *Somewhere* inspect buildings only. They do not know how to inspect lots, grading, sidewalks, grass, etc. And they will never learn. The line in the sand for a Building Inspector is two feet from the building wall so that he can inspect AC pads and building foundations. Infrastructure outside the building line is inspected by the Public Works inspector.

Subdivision Process Changes

Now that you understand the big picture of how the development process works, let's discuss how this would change if LID requirements were implemented.

While there are a host of micro BMPs in the LID toolbox such as rain barrels and trees in a box, the net impact of most these BMPs in the large scale new development picture is miniscule and are not acknowledged by permitting agencies. However, LID practices such as bioretention swales or rain gardens retaining runoff on individual lots can lead to measurable reductions of treatment and flood control volume in a regional pond. Therefore, for purposes of this paper, LID improvements will be called LID swales.

LID design calls for a different approach to designing and permitting stormwater systems, and just as importantly, changes the roles of the developer and homebuilder in the development process. Also, a fifth role is introduced to the development process, that of the **homebuyer**. The changes to the roles of these players is now examined under the scenario of requiring LID swales to be used where practical in new development.

Developer Role - The developer will still be responsible for installation of the roads, stormwater conveyance system, flood control ponds, and parts of the stormwater treatment system built in public right-of-way (ROW) or easements prior to: recording of plats, selling lots to homebuilders, and releasing of construction bonds. This sequencing of events shows the first important role change brought on by LID swales. If a developer were to install LID swales on each individual lot prior to construction of homes, he would still be responsible for maintenance of the swales during the homebuilding period. It would be inevitable that the swales would not survive untouched during the homebuilding process once the concrete trucks, framers, roofers, and multitude of contractors worked at the site for several months. The developer will not put himself in a position of being responsible for guaranteeing swale survival during house construction or the following one-year warranty period. This is the same reason a developer does not construct sidewalks and driveways prior to homebuilding.

The bonding, construction, and maintenance of this part of the stormwater system will therefore be shifted to the many homebuilders after the developer leaves the scene. In addition, the developer will not be able to complete final grading of the lots because the grading will depend on the LID swale construction. The homebuilder will also provide lot grading.

Engineer's Role – The engineer will now be required to provide additional stormwater calculations for the LID improvements. For illustration purposes, assume the standard requirement of meeting pre versus post discharge rates for a 25-year storm for flood control has not changed, and the new treatment criteria is to provide one inch of retention volume storage on each lot where feasible. Flood control will still necessitate construction of a regional detention pond, although the size of the pond and conveyance pipes are somewhat smaller due to LID volume reductions.

The use of LID swales is physically limited to locations where Type A or B soils exist and where the groundwater is at least 4 feet deep. As is typical in Florida, the soils and ground water elevations in *Somewhere* vary widely, with many areas not being conducive to dry retention requirements of a 48-hour recovery period. Poorly draining swales lead to many complaints to Public Works staff regarding mosquitoes, soggy bottoms, and cattail growth. Therefore, engineering design costs will be increased to determine which lots of a subdivision are suitable to onsite retention. These determinations will be conducted before overall modeling can proceed. In order to install LID swales in poor soils, an underdrain is sometimes promoted. Underdrains in *Somewhere* will not be allowed because they fail long term. The City would have no effective way to cause homeowners to replace underdrains and the City does not want to be responsible for replacing them.

The City will offer the engineer two design choices for calculating pond sizes with a volumetric model such as AdICPR.

- 1) Model each individual lot swale to account for reduced runoff volumes, resulting in a large multi-nodal model. The significant added expense of assembling an

accurate model of potentially hundreds of small LID ponds will rarely be cost effective and seldom performed.

2) Make general assumptions about reduced CN or initial abstraction values to account for runoff reductions and use a typical model with a few regional ponds having reduced sizes due to LID volume reductions.

With regards to the pipe modeling effort using the rational method for a 10-year storm, the runoff coefficient, C , could be reduced to account for LID swales volumes, potentially resulting in smaller pipes. The City will provide a new C factor table that can be used for lots with LID swales. There would be an increase in engineering design time and fees because the engineer will determine how many lots have LID swales and develop a composite C factor for a mixture of LID swale lots and non-LID swale lots.

One of the more significant issues of LID design and construction will be the placement of the LID swales. Ideally, retention swales would be constructed within the road ROW and replace curb and gutters as shown in Figure 1.



Figure 1 – Typical LID Bioretention Swale

Topographic limitations will generally prevent the storage of a whole one inch of retention volume within the road ROW in front of each lot, especially with the requirement to build those pesky sidewalks in a 40 or 50 foot ROW. *Somewhere* will not reduce pavement widths due to safety and access concerns from the fire department. The result will be either widening of required road ROW, reducing lot counts to the developer, or placing part or all of the LID swale outside of the ROW onto individual lots. *Somewhere* decided to allow LID swales to be placed inside the lot lines rather than go through the painful process of widening road ROW requirements.

Of course, the front lot scenario only works if the lots were graded to drain to the road. Many lots will be graded to drain to the side or rear property lines due to the terrain. In these cases, LID swales would be constructed interior to the lot lines or shared between two lots on each side of a lot line. Swales on lot lines will require:

1. Additional engineering design effort for lot grading
2. Possible reduced house foundation size on small lots with steep slopes
3. Limitations on the home buyer as to fence locations
4. Additional inspections by PWD inspectors to deal with these issues during construction and years down the road when homeowners innocently fence their lots blocking flows.

LID designs and construction will require increased plan review effort by the City, engineering design, survey layout after the home is built, inspection, and engineering as-built certification to assure the hundreds of swales and lot grading plans are constructed to the correct dimensions, location, and depth. Historically the engineer was hired to carry the developer only through the platting process. Now either the developer or the homebuilder will incur new engineering expenses of certifying construction of flood control and treatment capability to the Water Management District and City of individual lot swales and grading for however many years it takes to sell and build the homes. The engineer's role and expense in development will be shifted to the long term.

City's Role – The first step and expense of LID implementation for the City will be two to three years of rulemaking. Changing the development rules and procedures is an agonizing process for City personnel and the development community to undertake. Any new rules that increase engineering and development costs will be bitterly resisted. The reality is that political officials will be reluctant to go down this road during election years or economic hard times.

The next item that will lead to additional City costs is the long term maintenance of the LID swales. *Somewhere's* budget is already suffering with budget cutbacks. Public Works maintenance crews have more work than they can handle with keeping roadside ditches open and flowing for flood control purposes. The City will not accept additional maintenance responsibilities and costs. Whether the LID swales are located in the road ROW or on the lots, maintenance of these BMPs will become the responsibility of the Homebuyer.

If required retention systems are built on individual lots, easements dedicated to the City will be required over those retention areas so the City can ensure treatment capability required by TMDLs. If stormwater water quality goals required by TMDLs are not met because LID swales are not maintained, the state will hold the City, not the homeowners, responsible for restoring treatment capability of the swales. Therefore, specifically sized swales and easements will be designed by the Engineer for each lot. These easements will be recorded by the developer on the subdivision plat prior to selling the lots to homebuilders. The homebuilder, not the homeowner, will be responsible for constructing the swale within the easement boundaries. Plats will become cluttered with many small irregular shaped drainage easements. As a way to limit increased engineering and surveying costs for easement creation, drainage easement dimensions will become standardized, such as the front 15 feet of each lot, resulting in cookie cutter shaped swales with no room for customizing the swales by the homeowner.

An additional consideration will be the bonding requirements for construction of the required treatment facilities. Since the developer will not be required to construct the LID facilities and lot grading, he cannot be forced to bond that work. Additional time and expense will be incurred by the engineer and City plan reviewers as they calculate reduced bonding costs for the LID practices and grading.

Homebuilders will need the PWD to perform inspections and surveys for numerous LID swales, so the City will hire a new inspector to provide responsiveness for the tight deadlines necessary to obtain a CO. With the new inspector comes the cost of a new vehicle and required fuel.

Reorganizing the City's reviewing and inspection processes will incur hundreds of hours of manpower, internal meetings, and reprogramming of their computerized permitting software, all leading to lost productivity and inefficiency. To offset these many costs, the City will increase their permitting and inspection fees.

Homebuilder Role - The City normally has the hammer of the final plat to ensure prompt completion of the required stormwater system. Without that hammer, the City will use the CO as the tool to ensure that the homebuilder, rather than the homeowner, completes the LID swale. Here we have a new role for the homebuilder who will shoulder the cost of construction of LID swales. Some of the lots in the subdivision will be required to have swales and others not, depending on soils and water table characteristics. Developers will have a variable lot price structure, charging less for lots where LID swales are required to be built by homebuilders. When the homebuilder pulls a building permit he will now consult with the PWD to determine which of the lots will have LID swales. Historically the PWD has not been involved with building permits, but the homebuilder will need a PWD determination of the need for an LID swale and then PWD approval of the LID construction.

Remember, building inspectors do not inspect the lot. The homebuilder now faces an additional layer of delays for permits, inspections, and approvals from PWD in order to obtain his CO. He also has the additional expenses of hiring a surveyor to layout the swale, constructing the swale and lot grading, and engineering certification expense. The homebuilder will probably choose the most economical and expedient method of landscaping the swale, which is grassing rather than providing erosion control and landscaping it with aesthetic flowers and bushes. Using sod to grass a swale will not be permitted because the soil on the backside of the sod has a very limited infiltration rate and would defeat the purpose of infiltrating water rapidly. Therefore, the homebuilder may sod all parts of the yard except the LID swale, which must be seeded or stabilized with alternative methods.

Remember the swale will not be constructed until the home is almost completed. At that point the homebuilder often has a homebuyer ready to buy the house, close at the bank, and move in. These last few weeks of selling the house are a frantic struggle for the homebuilder to finish the house, obtain Building Department inspections, construct

sidewalks and driveways, and receive the CO. Thrown into the mix will be obtaining last minute surveys, inspections by PWD, swale construction, and certification by an engineer or surveyor. Experience has shown that it takes several weeks to receive a survey. COs are issued by the Building Department. Building Department officials will have additional checkboxes on their list as they coordinate with PWD inspectors, further slowing down the CO process.

The developer will incur reproduction costs by the engineer to provide additional plans to the many homebuilders, homebuyers, and surveyors involved in LID swale construction. The homebuilder will have the additional cost of providing a maintenance bond to cover the cost of maintaining the LID swale for one year. After the first year the PWD inspector will make another inspection and release the maintenance bond. At that point maintenance of the LID swale becomes the responsibility of the homebuyer. The homebuilder's role has changed from short term to long-term involvement in the building process.

The net result of the changes in construction sequencing is that the developer will no longer be required to provide treatment of stormwater runoff for his alteration of the land and street construction activities. The many homebuilders become responsible for construction of treatment swales. Completion of required treatment facilities for a subdivision will only occur when the last home is built. Until that time, the land in the subdivision will be polluting downstream waters at higher rates than allowed by TMDL mandates and permit requirements of one inch of treatment volume over the whole subdivision will not be met.

Another equally important change is that the developer will not be required to provide flood protection for a 25-year storm. He will construct smaller ponds for something less than a 25-year storm, leaving the homebuyers exposed to risk from hurricanes up until all LID swales are constructed. **Also, the smaller pipe system will not provide a 10-year level of service until all runoff reductions from LID swales are constructed by homebuilders.** Prior to construction of all LID swales the City has legal exposure by issuing a CO on properties with less than required flood control level of service protection.

Homebuyer Role - The new player in the stormwater treatment game will be the homebuyer. The homebuyer will be required to maintain the swale to the dimensions and depth designed by the engineer. A weak link in the maintenance chain will be informing all future homebuyers of their responsibility to maintain the LID swale. The only way to ensure future homebuyers are aware of this responsibility is with a specific statement and easement on the recorded plat. When the homebuyer closes on the lot, due diligence will reveal that LID maintenance responsibility is with the homebuyer, not the City or HOA.

Proper maintenance of LID swales is important for several reasons. The first is to ensure that the required one-inch of retention volume is provided to meet City TMDL commitments. Swales lose volume with time as grass thatch and sediment fill them in, reducing stormwater treatment effectiveness and flood protection. *Somewhere* will

continuously inspect LID swales and require homebuyers to excavate and revegetate their swales when the volume is reduced by 20% or when the swales stop infiltrating at a rapid rate. Also, in order to maintain maximum infiltration treatment in the swales, the homeowners will be prohibited from putting topsoil in the LID swales. *Somewhere* will hire a second PWD inspector to continuously inspect and enforce swale protection and maintenance after COs are issued. Currently only the Code Enforcement Department has fining powers. *Somewhere's* regulations will be rewritten to give the Public Works Department fining powers to ensure swales are maintained. Experience with roadside swale conveyance maintenance has shown that convincing a retirement based populace to undertake costs for swale maintenance will be difficult. The normal response will be calls to *Somewhere* politicians begging for relief.

The City will undertake the cost of a continuous broad based program of public education with the HOAs and on the internet to inform the homebuyers of their obligation to maintain the treatment and flood protection effectiveness of their swales. Hopefully homeowners will be encouraged to do their part to maintain their swales for environmental protection.

Summary

As can be seen in the above analysis, the implementation of LID based stormwater designs will require a fundamental change to *Somewhere's* development process. The responsibility for construction of part of a subdivision's stormwater treatment system will shift from one developer to many homebuilders. The development process will be necessarily more complex with the requirement to construct many more pieces of infrastructure by many more contractors.

Developers may have lower costs for pond construction, but will incur increased engineering expenses for design and platting of many small treatment areas. Engineers will benefit from additional design and certification requirements for many years as homes are slowly sold to homebuilders. Surveying fees will also be increased during the platting and homebuilding process.

Homebuilders will bear the cost burden for LID swales in terms of construction and maintenance bonds, construction surveying, construction, and new inspection fees. They may also experience delays in obtaining a CO due to additional swale inspections and certifications. Of course, these additional costs will be passed along to the homebuyers.

Somewhere will expend several years of time and expense in rulemaking to enable LID treatment facilities to be constructed with new development. Two new PWD inspectors will be employed, along with new vehicles. Public works personnel will be retrained to review plans for the use of LID swales, to change the bonding process, to change the plat review and recording process, to change the software used for tracking plans and plats, to make inspections during and after construction, and to integrate into the building department CO process.

All future homebuyers will be targeted by ongoing NPDES MS4 public education programs to ensure they understand their responsibility to maintain and periodically excavate their LID swales to ensure flood protection and stormwater treatment for environmental protection.

As a result of implementing LID practices into *Somewhere's* subdivision process, the size of traditional stormwater treatment ponds will be somewhat smaller, leading to an increase in number of developable lots. Costs of street construction will be reduced by eliminating curb and gutters. There may also be cost savings in a slightly smaller stormwater piping systems. Since the LID swales will offset traditional treatment methods, there will probably be no net increase in pollutant reduction.

On a macro scale, moving flood control facilities back into the watershed instead of concentrating them at one downstream point mimics natural hydrology by increasing overall times of concentration of the watershed. The biggest improvements will be in the aesthetics provided by increased landscaping breaking up the uniform pattern of traditional lot designs, giving a greener look to urban settings.